Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2020.25249

183 (2020) 366–373
April

Photocatalytic degradation of 2,4,6-trichlorophenol in aqueous solutions using synthesized Fe-doped TiO_2 nanoparticles via response surface methodology

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Received 15 June 2019; Accepted 27 November 2019

ABSTRACT

In this study, the photocatalytic degradation of 2,4,6-trichlorophenol (2,4,6-TCP) was evaluated under UV radiation by Fe-doped titanium dioxide (Fe-doped TiO_2) nanoparticles (NPs) which were synthesized by a sol-gel method. Diffuse reflectance spectroscopy (DRS), X-ray diffraction (XRD), and scanning electron microscopy (SEM) were applied to identify the synthesized nanoparticles. According to the SEM image, the synthesized nanoparticles had fine and irregular shapes with relatively smooth surfaces, as well as XRD spectrum showed that the crystalline size of Fe-doped TiO_2 NPs was 10.42 nm, furthermore, according to the DRS analysis, the bandgap energy of Fe-doped TiO_2 NPs was determined about 2.9 eV. The effects of operating parameters, including initial 2,4,6-TCP concentration, pH, contact time and Fe-doped TiO_2 NPs dosage on 2,4,6-TCP degradation were studied and optimized based on the response surface methodology with Box–Behnken method. The analysis of 2,4,6-TCP degradation showed that under optimum conditions, the removal efficiency reached 95.9% which is consistent with the model prediction. The optimum degradation conditions were as follows: pH, 3.29; initial 2,4,6-TCP concentration, 50.5 mg L^{-1}; Fe-doped TiO_2 NPs dosage, 0.59 g L^{-1}; and contact time, 55.7 min. The present results showed that Fe-doped TiO_2 NPs have great potential for removing 2,4,6-TCP from aqueous solutions.

Keywords: 2,4,6-TCP; Photocatalytic degradation; Fe-doped TiO_2; Response surface methodology

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